I claim:

1. A process for sustainable CO_2-free production of hydrogen and carbon via continuous thermocatalytic decomposition of hydrocarbons over carbon-based catalyst in air and/or water-free environment, employing continuous reactivation of the catalyst, comprising the steps of:
   (a) thermocatalytic decomposition of hydrocarbon stream over moving bed of carbon particulates in a reactor;
   (b) recovering a stream of hydrogen-containing gas (HCG);
   (c) directing said stream to a gas separation unit (GSU) where pure hydrogen is separated from said stream and hydrogen-depleted gas (HDG);
   (d) recovering pure hydrogen; and,
   (e) recycling said hydrogen-depleted gas to the reactor whereby the catalytically active carbon is generated on the surface of said original carbon catalyst.

2. The process of claim 1, including the step of: introducing an external combustion of a portion of said stream of hydrogen-containing gas (HCG) into said environment whereby there is an external activation of said carbon particulates.

3. The process of claim 1, including the step of: introducing an external combustion of a portion of said stream of hydrocarbon into said environment whereby there is an external activation of said carbon particulates.

4. The process of claim 3, wherein said hydrocarbon is a natural gas feedstock.

5. The process of claim 3, wherein said hydrocarbons contain sulfur.

6. The process of claim 2, including the step of: combustion of recovered carbon from said thermocatalytic decomposition process whereby the temperature of said decomposition is increased for sustainable production of hydrogen.

7. The process of claim 6, wherein carbon is withdrawn from the reactor, and a portion of it is directed to a grinder and, after it, to a heater, where heating and activation of said carbon catalyst occurs.

8. The process of claim 1, wherein said hydrocarbons is a hydrocarbon feedstock from natural gas to crude oil and mixtures thereof.

9. The process of claim 1, wherein internal activation of the carbon catalyst is occurs by recycling said hydrogen-depleted stream containing unsaturated and aromatic hydrocarbons to the reactor.

10. The process of claim 1, on wherein external activation of the carbon catalyst occurs via surface gasification of said carbon with hot flue gases arising from combustion of a hydrocarbon feedstock.

11. The process of claim 10, wherein additional external activation of carbon catalysts occurs by partial oxidation of aromatic hydrocarbons as byproducts of the process producing carbon black particles which adhere to a surface portion of said carbon catalyst.

12. The process of claim 1, wherein said thermocatalytic reactor is at a temperature of from about 800°C to about 1000° C.

13. The process of claim 1, wherein said thermocatalytic reactor transit time ranges from approximately 1 to approximately 60 seconds.

14. The process of claim 1, wherein thermocatalytic reactor pressures range from approximately 1 to approximately 25 atmospheres.

15. An apparatus for sustainable CO_2-free production of hydrogen and carbon via continuous thermocatalytic decomposition of hydrocarbons over carbon-based catalyst in air and/or

water-free environment, employing continuous reactivation of the catalyst, comprising the combination of:

(a) a thermocatalytic reactor with a stream having a moving bed of carbon particulates;

(b) means for recovering hydrogen-containing gas from said reactor;

(c) means for recovering pure hydrogen from said stream;

(d) means for recycling at least a portion of hydrogen-depleted gas to said reactor;

(e) means for disintegration of carbon particles after said reactor; and

(f) means for heating of carbon particles.

16. The apparatus of claim 15, where the moving bed reactor is a fluidized bed reactor.

17. The apparatus of claim 15, where the carbon-based catalyst is carbon black.

18. The apparatus of claim 15, where the means of recovering pure hydrogen is a membrane gas separation unit.

19. The apparatus of claim 15, where the means of disintegration is a grinder.

20. A process for production of electricity and carbon comprising the steps of:

A. producing hydrogen by:

1) thermocatalytic decomposition of hydrocarbons over a fluidized bed of carbon particulates;

2) recovering a stream of hydrogen-containing gas (HCG);

3) directing said stream to a gas separation unit (GSU) where pure hydrogen is separated from said stream and hydrogen-depleted gas (HDG);

4) recycling said hydrogen-depleted gas to the reactor whereby catalytically active carbon is generated on the surface of said carbon particulates; and

5) recovering pure hydrogen;

B. continually introducing said pure hydrogen into an anode of a fuel cell;

C. continually passing air into a cathode of a fuel cell; and

D. producing electricity and recovering carbon.

21. An apparatus for generating electricity and producing carbon, comprising the combination of:

a) a thermocatalytic reactor with a moving bed of carbon particulates;

b) means for recovering hydrogen-containing gas from said reactor;

c) means for recycling at least a portion of hydrogen-depleted gas to said reactor;

d) means for disintegration of the carbon particulates after said reactor;

e) means for heating of carbon particles;

f) means for recovering pure hydrogen from said stream; and

g) means for transporting said pure hydrogen into anode of a fuel cell, whereby electricity is generated.

22. The apparatus of claim 21, where the moving bed reactor is a fluidized bed reactor.

23. The apparatus of claim 21, where the carbon particulate is carbon black.

24. The apparatus of claim 21, where the means of recovering pure hydrogen is a membrane gas separation unit.

25. The apparatus of claim 21, where the means of disintegration is a grinder.

26. The apparatus of claim 21, where the means of transporting and generating electricity is a polymer electrolyte membrane fuel cell.